



2001

# T'ai Chi Chih and Its Effects on Balance and Blood Pressure

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T'AI CHI CHIH AND ITS EFFECTS ON BLANCE AND BLOOD PRESSURE

by

Sarah L Williams  
Bachelor of Science in Physical Therapy  
University of North Dakota, 2000

An Independent Study

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine

University of North Dakota

in partial fulfillment of the requirements

for the degree of

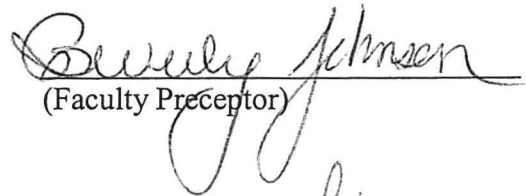
Master of Physical Therapy

Grand Forks, North Dakota  
May  
2001

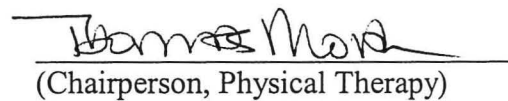




This Independent Study, submitted by Sarah L Williams is partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and I hereby approved.

  
(Faculty Preceptor)

  
(Graduate School Advisor)

  
(Chairperson, Physical Therapy)



## PERMISSION

Title            T'ai Chi Chih and its Effects on Balance and Blood Pressure

Department    Physical Therapy

Degree           Master of Physical Therapy

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Signature Joseph Williams

Date 12/20/00

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## **ACKNOWLEDGEMENTS**

I would like to thank Jen and Anita for all the fun we had working on this study and for keeping me organized. I would like to thank my preceptor, Bev, for helping me meet the deadlines for this study and for her expert proofreading skills. Also, thanks to the amazing Alyson, for without her no physical therapy student would ever graduate from UND-PT.

To Jen, Jana, Kip, Jay, Mark and Rhett, thanks for the friendships and may we never lose touch with one another.

To my family, especially Dad, Grandma and Uncle Pete, thank you for your endless love, support and generosity. I am forever grateful to you all for instilling in me a will to succeed and a drive for excellence.

Last, and most important, thank you Mom and Grandsoder for giving me strength and inspiration in everything I do.

## **ABSTRACT**

Eastern philosophies and alternative medical practices, such as T'ai Chi Chih (TCC), a gentle form of exercise and meditation, are gradually becoming more mainstream in western culture. Although there are many benefits to using TCC, most of the literature relates to the elderly population. This study investigates the impact regular TCC practice has on blood pressure and balance in a younger population.

Twenty subjects, ages 20-39, were randomly assigned to either a TCC or walking group. Initially, all subjects had their blood pressure checked, their balance tested on the NeuroCom® Balance Master, single leg stance and functional reach tests to determine baseline data. The TCC group participated three times a week for 45-60 minutes, for five weeks. A certified TCC instructor led one session a week and the investigators led the other two, with the assistance of a video. One of the investigators led the walking group, up to 45 minutes three times a week, for five weeks.

After five weeks, both groups repeated the balance master and blood pressure tests. Statistical analysis showed a significant decrease in systolic and diastolic blood pressure in the TCC group and a significant increase in left single leg stance time, with eyes closed, in the walking group. These results provide significant information on the ability of TCC to reduce blood pressure in a younger population, and add to the information on the use of TCC as a treatment option for patients with various types of health concerns.

# **CHAPTER 1**

## **INTRODUCTION**

“Balance...it starts within...”<sup>1</sup>

Historically, the primary difference between eastern and western medical practice has been their philosophies on the relationship between the mind and body.<sup>2</sup> Eastern medicine emphasizes the idea that the mind and body are interdependent, interrelated and impossible to treat as separate entities. Western medicine tends to separate mind and body and views their internal workings as distinct.

Eastern philosophies and alternative medical practices, such as T'ai Chi Chih practice, are gradually entering and becoming more mainstream in western culture. The Chinese have believed in and benefited from T'ai Chi Chih practice, with enhanced well-being and health, for 5000 years. Even so, western culture has been slow to accept this practice because of our society's need for documentation and well-researched results before initiating the use of such an unfamiliar activity.

### **Problem Statement**

Recently the National Institutes of Health identified T'ai Chi on a list of alternative therapies that will be isolated for research funding and a formal area

for investigation.<sup>3</sup> Research has been conducted exploring the benefits of T'ai Chi practice in the elderly and those with various health concerns, but it is limited. More research is needed to discover the effect T'ai Chi has on healthy young adults. If this exercise is found to be beneficial to a younger population, ages 20-39, it can almost completely be assumed T'ai Chi would have similar if not more profound results in all other adult populations.

### **Purpose**

The purpose of this study is to determine if balance can be improved and/or blood pressure can be reduced in adults ages 20-39 by practicing T'ai Chi Chih three times a week for six weeks.

### **Significance**

As health care professionals in today's diverse society, we need to expand our practice to include a variety of activities and treatments to help our patients reach their goals. In order to be successful, a broad knowledge base of both traditional western treatments and alternative therapies is needed. The more varied a therapist's treatment options, the greater the chance for successful treatment and recovery. It is important to realize that conventional treatments may work for most patients, but may have little or no effect on others. A physical therapist with a repertoire of traditional treatment options, supplemented by alternative therapies, will have more success than one who doesn't accept more progressive methods, when encountering patients who aren't responding well to traditional techniques.

This study will help determine if T'ai Chi Chih is effective in improving balance and/or decreasing blood pressure in healthy 20-39 year-old adults. If T'ai Chi Chih is



found to be effective in this population, we can assume it will be beneficial to those with greater physical limitations and added to a physical therapist's options for treatment.

### **Research questions**

1. What is the effect of a five-week T'ai Chi Chih program on dynamic balance in subjects ages 20-39?
2. What is the effect of a five-week T'ai Chi Chih program on blood pressure in subjects ages 20-39?
3. What is the effect of a five-week T'ai Chi Chih program on static balance in subjects ages 20-39?
4. What is the effect of a five-week T'ai Chi Chih program on limits of stability in subjects ages 20-39?

### **Hypothesis**

$H_0$ : A T'ai Chi Chih program will have no effect on dynamic balance, blood pressure, static balance, and/or limits of stability in subjects ages 20-39 after practicing three times a week for five weeks.

$H_A$ : A T'ai Chi Chih program will improve dynamic balance, reduce blood pressure, improve static balance and/or limits of stability in subjects ages 20-39 after practicing three times a week for five weeks.

## **CHAPTER II**

### **LITATURE REVIEW**

Until recently, western medicine ignored and even shunned holistic, alternative approaches to traditional treatment. "Medical quackery" was a phrase used by the AMA to describe those with different understandings of the body or different ideas of what healthy meant.<sup>4</sup> In 1967, the AMA even went so far as to tell its members that it was unethical for a physician to associate professionally with chiropractors.

A lot has changed in the medical profession since those days. Throughout the 1970's and 80's, a trend to mainstream holistic healthcare occurred, and by the 1990's, a major validation for alternative healthcare took place when insurance companies agreed to cover alternate therapies for their members. Currently, at least 14 major insurance companies and two thirds of HMO's cover some form of alternative therapy.<sup>4</sup> One HMO even predicted that by 2001 all of their members would have coverage.

Insurance companies are paying for complimentary therapies because their members are demanding it. Almost three-fourths (71%) of surveyed adults believe that consumer demand for holistic health care will be moderate to strong in the future, while only five percent think it will be nonexistent.<sup>4</sup> Even the AMA is responding to the increase in their patients' use of alternative therapies by dedicating an entire 1998 issue to alternative medicine in an effort to provide physicians current, quality information on the subject.

Considering this incorporation of holistic medicine into traditional techniques, it is important for health care providers to understand the basic philosophy of its practitioners. Most people, whether they subscribe to holistic theory or not, understand it is impossible to separate the body from the mind or vice versa. This idea is the basis for holistic practice, therefore practitioners believe in order for complete healing to take place they must treat aspects of both mind and body. Most believe the body contains some form of vital energy (acupuncturists=chi) and has the ability to heal itself.<sup>4</sup> Holistic medicine practitioners believe the physical body as well as the brain, mind, emotions and spiritual aspects of the body must all be incorporated into effective treatment.<sup>2</sup> It makes sense, if the processes of the mind and body cannot be separated in function, then both aspects should be considered and addressed in treatment of patients with sickness or injury.

Mind and body exercise is one of those treatments that is purported to enhance the mind and body through training of motor coordination (processes of posture and movement) and somatosensory function (awareness of body structure and relationships of body parts).<sup>2</sup> The practitioners of alternative therapies believe effective movement is essential to nervous system development, not excluding cognition and consciousness.<sup>2,5</sup> Motor function cannot be separated from psychological process, so it is thought by training both the neuromuscular and psychological systems patients will be able to meet physiologic and psychological demands more efficiently.<sup>2,6</sup>

T'ai Chi is one type of movement therapy that works by incorporating both motor control and motor learning to improve coordination and somatic education in general.<sup>2,5,7,8</sup> It has become a very popular form of exercise for performance

enhancement and general wellness, and can be combined with physical therapy for rehabilitation of many types of patients.<sup>2,9</sup>

### **History of T'ai Chi**

T'ai Chi is a type of exercise and mediation that has been practiced in China for years. Some of the literature gives Chang san Feng, of the Wu Tang monastery, credit for developing the original form of T'ai Chi about 700 years ago.<sup>10</sup> Feng lived around 1391-1459, of the Ming Dynasty, when self-defense against warlords and peasant insurrections was needed. (6) With the use of T'ai Chi, one could subdue an aggressor through a soft flow of movements designed to use the attacker's energy against them. The force is dissipated through the body of the defender, and the attacker is then sidestepped and thrown off balance.<sup>8,10,11</sup>

Chang san Feng may have developed T'ai Chi into its martial art form, which is no longer in use today, but it has actually evolved through many forms over thousands of years. Modern day forms started out as a type of breathing meditation, later T'ai Chi was used as an effective type of self-defense, and finally, today it is a slow, gentle, rhythmic, artistic form of physical and mental exercise.

Now, T'ai Chi exists in hundreds of different forms passed down from generation to generation in China.<sup>3,11</sup> Each form consists of a series of 20-108 fluid movements, and many styles exist associated with, and named for, the family or group that developed its unique movements (e.g., Chuan Style, Chih Style, Yang Style, Wu Style).<sup>4</sup> Although each style appears distinct, they all share classic T'ai Chi principles and basic Tao philosophies.

## Philosophies of T'ai Chi

Taoism, the basis for T'ai Chi philosophy, is a Chinese ideology dating back to the sixth century B.C., and is still in use today.<sup>3</sup> The basic concepts of Taoism include the existence of an internal energy, or life source (chi), and the idea of an opposing balance of forces, diagramed in the familiar T'ai Chi T'u (figure 1).



Figure 1. T'ai Chi T'u diagram

The two forces, called Yin (inactivity, negative, black) and Yang (activity, positive, white), have been the basis of the Chinese understanding of health and sickness for centuries.<sup>3</sup> Notice the small spot of white in the larger black and the small spot of black in the larger white; demonstrating visually there is always some good with the bad, positive with the negative, rest with activity, etc. Optimal health requires a balance of the opposing forces through exercise and meditation, or use of both mind and body.

T'ai Chi movements are an effective way of providing mind and body exercise.<sup>3,4</sup> T'ai Chi, a form of movement, is thought to represent Yang- the white portion of the T'ai Chi T'u, and meditation, which involves quiet and rest, is Yin-the black portion.<sup>3</sup> To perform T'ai Chi requires inner quiet and rest while performing outwardly visible movements or exercise. The inner aspect of each of these practices is opposite to its outer aspect.

In addition, movements are performed in pairs of opposites with the Taoist philosophy in mind. For example, motion that ultimately involves rocking forward starts with a slight rocking backward, or a movement that involves moving right begins with a slight move to the left.<sup>3,12,13</sup> Though the philosophy and techniques may seem technical or difficult, T'ai Chi is a very simple exercise, which "has proven to be the most advanced system of body exercise and mind conditioning ever created".<sup>3</sup>

### **Principles of T'ai Chi**

We are very logical and intellectual in the west, so when we try to fit T'ai Chi into a neat definition, or develop our own ideas about it, we miss its essence. "Trying to categorize it (T'ai Chi) is like three blind men describing an elephant while each one holds on to a different part of it".<sup>14</sup> T'ai Chi is both personal and impersonal, tangible and elusive, therefore can take on many definitions of practice. The many different styles of T'ai Chi can also make it difficult to describe exact principles of practice, but all styles share a few common principles that apply to both the mind and body.

First, relaxation of the mind, and relaxation of the body must occur. The mind must be alert, yet calm, to become aware of the body movements in space--mindfulness.<sup>14</sup> The body must be relaxed yet prepared to react to the movement commands coming from the mind.

Next, postural alignment is important. The body must be upright yet relaxed with the shoulders aligned over the hips.<sup>14</sup> The wrists remain in neutral position, unless specified by the movement, also as an element of relaxation.

Correct technique while performing the movements is another important principle of T'ai Chi practice. The movements originate at the waist and the body moves as a

column with little or no twisting.<sup>10</sup> Then, the feet legs and arms are used, in different ways specified by each movement, to circulate and balance the chi, or energy.

These are the very basic principles that all T'ai Chi styles share. As mentioned before, some styles of T'ai Chi can involve up to 108 movements. Few people have the motivation or time to learn and practice so many movements. As a solution to this problem, a man named Justin Stone developed a shorter form of T'ai Chi, called T'ai Chi Chih (pronounced *tie chee chuh*), which involves 20 simple movements and takes only 20-30 minutes to perform the complete routine. His plan when developing T'ai Chi Chih was to create a form, based on the ancient philosophies and principles that would be easy to learn and practice, but still provide the benefits of the longer forms.<sup>14</sup>

T'ai Chi Chih was the form used in this study because of time constraints and to increase interest and compliance, so a more detailed description of its principles is necessary.

### **Principles of T'ai Chi Chih**

T'ai Chi Chih can be learned and practiced by anyone, there are no contraindications to any form of T'ai Chi. Many books and videotapes can instruct a learner in the effective practice of T'ai Chi, but a more serious learner would want to consult an experienced practitioner for a complete understanding of T'ai Chi and its complex philosophies and principles. It is up to the learner as to what level of mastery they wish to attain, but mastery is not necessary to obtain benefits.

For beginning students the most important aspect of T'ai Chi is to learn how to move.<sup>14</sup> A few "musts" of practice should be kept in mind at all times while learning the

art of T'ai Chi: softness at all times, slow even movements, and no effort. The rest of the principles build on those very basic ideas of practice.

To begin, the mind must be clear and free of extraneous thoughts.<sup>14</sup> It helps to concentrate on the soles of the feet or below the navel while performing the movements. This procedure takes practice, but is a welcome instruction in today's high stress environments.

Recommended posture includes keeping the body relaxed, the hands soft and the wrists loose and pliable.<sup>10</sup> Fingers are slightly spread apart, the hands slightly cupped as though around the sides of a ball.<sup>14</sup> At all times the torso from the waist up should be held straight, not rigid, and completely relaxed. The head and torso are held in an erect position as though suspended from the ceiling by wires. The tailbone is pressed slightly forward and the navel is pressed against the backbone. The shoulders are relaxed and drooping and the hands move in soft circular motions. It is not necessary to concentrate on all of these specifications at once, just to be aware of their existence, as with practice they will become natural and automatic.

During the movements, the knees are slightly bent and the weight shifts from left to right or front to back. The individual is told to imagine they are "swimming" through very heavy air to emphasize the importance of slow, leisurely motions. To weight shift correctly, the back heel should come off the ground when moving forward, and when shifting the weight backward the front toe comes off the ground, as a demonstration of the T'ai Chi T'u diagram. T'ai Chi Chih should not be done stiff-legged, but rather involve a gentle rocking motion. This is referred to as the "yinping" and "yangping" of the legs, or shifting of the weight from the "substantial" to the "insubstantial" (yang and



yin), and is a very important principle of T'ai Chi Chih. It is with weight shifting the energy, or chi begins to circulate, balance is challenged, and a moderate level of aerobic exercise is attained.

Each one of the 20 movements (table 1) is usually repeated 9, 18, or 36 times on the right and again to the left. Preferably, practice is continuous, soft, and slow. It is up to the learner, however, as to how often or how many times a day they wish to practice, however daily practice is ideal.

Table 1. T'ai Chi Chih Movements

1. Rocking
2. Bird flaps its wings
3. Around the platter
4. Around the platter variation
5. Bass drum
6. Daughter on the mountain
7. Daughter in the valley
8. Carry the ball
9. Push/ Pull
10. Pull the energy
11. Basic taffy
12. Anchor step taffy
13. Circles taffy
14. Perpetual motion
15. Working the pulley
16. Light on the top of the head; Light at the temples
17. Joyous breath
18. Passing clouds
19. Six healing sounds
20. Cosmic consciousness

### **Benefits of T'ai Chi**

While many westerners may be uncomfortable with the ideas of opposing forces, Chi, and many other progressive ideas because they lack significant research of their existence, they should feel comfortable with the physical benefits of T'ai Chi. To satisfy

the western need for proof, much scientific research has been conducted supporting the cardiovascular, musculoskeletal, respiratory, postural, and balance benefits of T'ai Chi in its practitioners and the elderly.

T'ai Chi has been shown to increase strength, flexibility, improve posture, enhance balance, reduce blood pressure, provide arthritic improvements, shorten post surgical recovery, decrease stress, provide an aerobic workout, reduce the risk of falls and improve balance in the elderly, and provide an overall sense of well being and confidence.<sup>10,15</sup>

### Balance

To better appreciate and understand the benefits of improved balance through T'ai Chi practice, an explanation of balance and the controls of balance are necessary. Balance is defined as stability produced on each side of a vertical axis, with the vertical axis being the body.<sup>16</sup> The balance control system serves to maintain the center of mass (COM), relevantly, over the base of support (BOS) through multiple central nervous system (CNS) inputs and outputs. This alignment is achieved with the help of three major system components: (1) sensory elements responsible for detection of body motion, (2) sensory interaction processes, and (3) musculoskeletal elements.

Function of the three components cannot be separated, they all work together to maintain balance, but they will be discussed here separately. First, the visual system plays a large role in detecting body motion.<sup>16</sup> It detects the relative position of the body with reference to the environment and gives the CNS information about the environment's organization. Righting reactions of the head, trunk and limbs, to keep the

body upright when the COM is displaced, and visually guided movements are all motor functions of the visual system.

Other sensory information relative to the detection of body movement is obtained through cutaneous sensations from body parts (i.e., feet) in contact with a support surface and muscle and joint proprioceptors (somatosensory information).<sup>16</sup> Relative orientation and movement of body parts and orientation of the support surface are perceived in this manner. Stretch reflexes, flexor withdrawal reflex, crossed extensor reflex and automatic postural reactions are all motor functions of the somatosensory system. Significant somatosensory inputs that assist in maintaining balance are touch, pressure, and joint position sense.

The last system, which contributes to the detection of body motion, is the vestibular system. It detects the orientation of the head and angular and linear acceleration and deceleration forces acting on the head.<sup>16</sup> The vestibular system serves to stabilize gaze during head movements, control muscle tone and postural muscle activation, and keep the head upright with righting reactions of the head, trunk and limbs.

All this sensory information is used by the central nervous system (CNS) selectively.<sup>16</sup> All sensory inputs contribute to a sense of equilibrium and maintain the COM over the support surface. Normally, the somatosensory system is enough to maintain this equilibrium, on a stable support surface and with stable surroundings. When the support surface is disturbed or the patient had a somatosensory deficit (i.e., proprioception), vision will be the primary means to maintain balance. If both somatosensory and vision systems are altered or have deficits, then the vestibular system will take over. With multiple systems acting to maintain upright, balance can be

controlled in the absence of vision and in a variety of situations. However, if more than one sensory system is affected, or with pathology of the CNS, obvious lack of balance control will occur.

Loss of balance occurs when the body exceeds the maximum angle from vertical it can be tolerated, or its limits of stability (LOS). The body uses a variety of musculoskeletal inputs from muscles, joints, ligaments or a combination these, to avoid exceeding its LOS.<sup>16</sup> During relaxed standing, there is a normal, minimal amount of movement that occurs as the body continuously corrects and re-corrects to keep the COM over the BOS, which is called postural sway. If the COM is displaced in some way, however the body will react with a postural response relative to the intensity of the displacement to attempt to stay within the LOS. Postural control of LOS is maintained through specific, automatic postural synergies (ankle strategy, hip strategy, and stepping strategy) that keep the body upright and prevent falls.

The ability of the body to prevent falls decreases with age. With aging comes a decrease in balance and an increase in postural sway.<sup>16</sup> As a result movements within the LOS will be altered, or the LOS will be decreased. It will take less force, for example, to disrupt balance and cause the elderly person to fall. Activities focused on challenging their LOS and re-training their balance control systems can decrease the onset and progression of balance deficits.

Considering balance and how it is controlled, it is easier to appreciate the research conducted on the ability of T'ai Chi to promote postural control, improve balance, and prevent falls. For example a study performed by Tse and Bailey<sup>17</sup> found T'ai Chi practitioners had significantly better postural control than sedentary non-practitioners.

Judge et al<sup>18</sup> found improvements in single leg stance and postural sway in older women using T'ai Chi exercise. Jacobson et al<sup>19</sup> found T'ai Chi improved lateral stability, kinesthetic sense and strength of voluntary knee extension as compared to a group of non-exercisers.

T'ai Chi participants also develop the important sense of how to control their bodies in a variety of positions and get a better sense of where their body is in space, as demonstrated in a study by Forrest.<sup>20</sup> Forrest found participants in a T'ai Chi program gained a greater awareness of postural equilibrium (sense of where the body is in space) through the increased use of peripheral structures involving muscles, ligaments and tendons. This increased body and postural awareness may contribute to the reason Wolf et al<sup>21</sup> found T'ai Chi practice delayed the onset of falls and reduced the occurrence of falls by 47.5 percent when compared to a group trained using computerized balance training. A group of community dwelling elders reported less fear of falling and increased confidence after T'ai Chi practice. A secondary gain in Wolf's study was found after the conclusion of the experiment, as the T'ai Chi group continued to practice. Also, Province et al<sup>22</sup> concluded treatment programs containing elements of T'ai Chi exercise (flexibility, balance, dynamic balance, and resistance) reduce the risk of falls in the elderly.

With all of this significant information on the ability of T'ai chi to improve balance it's no wonder T'ai Chi is also being recommended as a balance training tool in patients with bilateral vestibular lesions to improve balance, flexibility and increase strength.<sup>23</sup> T'ai Chi can accompany traditional balance programs for all patients lacking postural, proprioceptive or vestibular control. Not only is T'ai Chi an appropriate tool to

compliment any Physical Therapy balance-training program, but it is also an enjoyable exercise capable of increasing patient compliance.

### Cardiovascular

T'ai Chi also can have a positive effect on the cardiovascular system and blood pressure. Blood pressure refers to the force the blood exerts on a vessel wall during contraction and relaxation of the heart.<sup>16</sup> Since the heart is a pump producing a period of high pressure and a period of low pressure, both extremes are measured when assessing blood pressure. The highest pressure is represented by the systolic measurement (ventricular contraction) and the low measurement by diastolic pressure (ventricular relaxation).

Blood pressure is regulated by the vasomotor center located in the pons and the medulla of the brain stem. It sends signals to all the vessels in the body to produce a continual firing of vasoconstriction nerve fibers.<sup>16</sup> This firing maintains a partial state of contraction in all vessels to provide a stable arterial pressure. The vasomotor center is closely connected to the cardiac-controlling center, as changes in cardiac function will affect blood pressure. Both the cardiac and vasomotor systems require input from receptors in vessel walls. These receptors are responsible for giving updates, on blood pressure throughout the body and blood oxygen concentrations, to the controlling systems.

Several factors can influence the cardiac and vasomotor systems in controlling blood pressure, which should be taken into consideration when assessing it. First, a change in blood volume will affect blood pressure. An increase in blood volume will increase blood pressure and vice versa. Also, the diameter and elasticity of the vessel

walls will affect blood pressure by providing resistance or decreased resistance. Temperature, or other factors will affect the diameter of the vessel by constricting or dilating it and increasing or decreasing blood pressure. While age will decrease the vessel's ability to expand and recoil which will increase resistance and increase blood pressure.<sup>16</sup> Next, increased amounts of blood pumped in to the arteries will increase blood pressure by distending the vessels and the opposite is also true. Physical activity will also affect blood pressure. Increased activity will increase cardiac output, which in turn will increase blood pressure. Last, blood pressure may be affected by arm position during measurement.<sup>16</sup> To ensure consistent measurements, the patient's arm should be supported in a horizontal position at heart level.

This information should help understand why studies have shown that T'ai Chi is an aerobic exercise of moderate intensity<sup>3</sup>, and has significant positive effect on the cardiovascular system. A study conducted by Wolf et al<sup>8</sup>, on an elderly population, found T'ai Chi had similar cardiorespiratory benefits to those of brisk walking. Lai et al<sup>24</sup> conducted a study, which found elderly T'ai Chi exercisers had a significant improvement of VO<sub>2</sub> uptake compared to sedentary elders. Also, Young et al<sup>25</sup> found T'ai Chi significantly reduced blood pressure in the elderly after a 12 week program, and British researchers found T'ai Chi lowered heart rate and blood pressure in patients participating in a cardiac rehabilitation program.<sup>15</sup> Channer et al<sup>26</sup> compared a T'ai Chi group to a traditional aerobic cardiac-rehabilitation group and found significant improvements in blood pressure, heart rate, and respiratory response to exercise in both groups, but compliance was better in the T'ai Chi group. Overall, T'ai Chi is has been proven to be a suitable exercise for older adults and patients with impaired cardiovascular

function, and can be used as an alternative to regular aerobic exercise of moderate intensity. In addition, T'ai Chi has proven to be an enjoyable activity for patients and may improve compliance with aerobic exercise programs of moderate intensity.

The purpose of this study is to determine if a five-week T'ai Chi Chih program has an effect on balance and/or blood pressure in subjects ages 20-39. The results will add to the growing body of knowledge on the benefits of regular T'ai Chi practice.



## **CHAPTER III**

### **METHODS**

The final approval for this study was obtained from the University of North Dakota Institutional Review Board for the use of human subjects. A copy of the human subjects review form is located in Appendix A. During recruitment, the components of the study were explained to those interested in participating. A copy of the written informed consent form, and a copy of the T'ai Chi Chih instructor's agreement to participate in the study, is located in Appendix B.

#### **Subjects**

To test the hypothesis for this study, human subjects were needed. Volunteers were recruited from the University of North Dakota through e-mail and the word of mouth, and consisted of students and teachers. Inclusion criteria consisted of the following:

- 1) Between ages of 20-39
- 2) Participate in cardiovascular exercise no more than three days a week for 40 minutes a time
- 3) No history of cardiac problems
- 4) Blood pressure within normal limits
- 5) Able to attend a majority of training sessions and both assessment sessions

Eighteen subjects participated in the study. One female in the T'ai Chi Chih group was released due to scheduling conflicts. Also, two subjects who were part of the walking group dropped out because of unknown causes.

### **Instrumentation**

Data collection consisted of testing performance for the single leg stance, functional reach, and rhythmic weight shift utilizing the Neurocom Balance Master<sup>®</sup> (NBM). Blood pressure was also assessed for each subject. During the second assessment, the subjects were measured with their shoes off for their approximate height. Each specific test was conducted by the same researcher for each subject during both pre and post test days to eliminate the potential of inter-rater reliability.

### **Blood Pressure**

Blood pressure was assessed before and after the intervention using a standardized blood pressure machine. Prior to the pre-test day and post-test day, the machine was calibrated by Altru Biomedical Resources. Each subject consistently had their blood pressure tested prior to the other tests to ensure a normal resting blood pressure. The following procedure was used to assess each subject's blood pressure.

1. The subject was seated in a chair with his/her right arm resting on a table at the level of their heart.
2. The blood pressure cuff was placed on the right arm with the arrow on the cuff pointing to the brachial artery.
3. The researcher pushed the start button and waited to read the blood pressure as tested by the blood pressure machine.

4. Subjects were also questioned about caffeine intake and stress levels to assure consistent blood pressure reading.

#### Single Leg Stance

The single leg stance test was selected to measure balance with eyes open and eyes closed. It is a test widely used both in the clinic and in studies of balance and exercise. Reliability is reported to be good with internal consistency reliability coefficients of .85 to .95.<sup>27</sup>

The single leg stance was performed with their eyes open two times each leg and eyes closed three times each leg. If the subject was able to balance on one leg for two minutes, that trial was complete. The tests were stopped by the researcher if the subjects lost their balance, touched the wall, touched their other leg to the floor, touched their legs together or opened their eyes during the eyes closed tests. The times kept by the researcher with a stopwatch were averaged for both eyes open and eyes closed and reported for the statistical tests.

The following directions were given to each subject prior to the test:

1. Cross your arms across your chest.
2. When the test begins, you will stand on one leg and bend the other knee to ninety degrees.
3. Do not let your legs touch.
4. When you are ready, lift your leg and I will start the stopwatch.

#### Functional Reach Test

The Functional Reach Test (FRT) was developed to measure the margin of stability during maximal forward reaching.<sup>28</sup> It was selected by the researchers to

measure and detect a possible change in balance before and after the intervention. As tested by Duncan et al<sup>28,29</sup>, the FRT was shown to be highly reproducible with the intraclass correlation coefficient of .92.

Equipment for the functional reach test consisted of a yard stick (3 inch x 48 inch) taped on the wall parallel to the floor. The subject stood on a large piece of paper that was taped to the floor next to the wall. The subject's feet were traced to guarantee the same base of support for the second test time. The subject performed the test barefoot and with their dominant arm, which was placed nearest to the wall.

The following instructions were given to each subject:

1. Stand with your feet apart in a comfortable stance.
2. Make a fist with your dominant hand and bring your shoulder 90 degrees.
3. Reach forward as far as you can, keeping your heels on the floor and your knees straight. Do not twist at the waist.

One researcher would measure the starting distance by using a ruler as a straight edge to align the third metacarpalphalangeal (MCP) joint with the point on the yardstick. The subject was then told to reach forward as far as possible. The subjects were not allowed to touch the wall and there were no attempts to control the subject's method of reach. The placement of the third MCP was again measured. A second researcher recorded the measurements to the nearest 1/8 inch. Each subject was given two practice trials and three recorded trials. The difference between the two points was calculated and the three trials were averaged for the statistical tests.

### Rhythmic Weight Shift

The NBM was used to assess rhythmic weight shift. A detailed description of the rhythmic weight shift test is found in Appendix C. This machine is widely used in the physical therapy profession for both assessment and training of balance. The subject stands on two nine inch by sixty inch force platforms on top of four load cells that measure the force under each foot.<sup>29</sup> This platform communicates with a computerized system that interprets multiple data obtained during assessment and training. The computer provides visual feedback to the patient and therapist through the computer monitor, which is positioned at eye level to the subject. The cursor, which represents the patient's center of gravity (COG), moves with the patient's minute COG displacement. As the cursor moves, it draws yellow lines showing the exact movement of the patient. Objective and quantitative data is available on printouts depicted as graphs, numerical charts and traced pictures that reveal the COG movement.

Liston and Brouwer<sup>30</sup> conducted a study, comparing the NBM to the Berg Balance Scale and to gait velocity, which showed the NBM to be valid for the dynamic measures of balance only. According to the Balance Master Manual<sup>29</sup>, the rhythmic weight shift test has moderate reliability when testing normal adults.

Rhythmic weight shift was the last test the subjects performed on both test days. Each subject performed the test with his/her shoes and socks off. Due to the high learning curve that exists when using the NBM, it was important to allow the subject time to become familiar with the force plates through a practice session.

The following instructions were given to each subject prior to the test:

1. Shift your weight side to side to make your cursor follow the blue square, keeping both of your feet in contact with the force plate at all times.
2. Try to move the exact same speed the square is moving.
3. Try to move as straight and smooth as you can.
4. Try to change directions at the line, just as the square does.
5. Try to be the square.
6. Take as much time as you need to feel comfortable, and when you say ready we will be begin testing.

### **Intervention**

After recruiting 18 subjects, they were randomly placed into two different groups. Group 1 (n=11) served as the T'ai Chi Chih group and participated in T'ai Chi Chih classes three days a week for 45 minutes each session. T'ai Chi Chih is a modified short form of Tai Chi that was developed by Justin Stone.<sup>14</sup> He developed this form after finding that many students couldn't master the more complicated form of T'ai Chi. Stone's form consists of 19 repetitive movements and one pose that are simple and more adaptable to those students with some degree of physical or functional limitation.

One class a week was taught by a certified T'ai Chi Chih instructor, which the researchers videotaped. The two remaining days of classes were led by the researchers, with the help of the video of the certified instructor. The majority of the classes were held at the International Center's Lotus Meditation Room. This room was well lit and had hardwood floors. There was also soft background music playing during the classes. When the weather permitted, some of the classes were held outside. Subjects were either barefoot or wore socks during the classes.

Group 2 (n=7) served as the walking group and was instructed to walk three times a week for 45 minutes. They also were instructed to stretch their hamstrings during sitting or standing for one minute each leg before and after they walked. They met as a group for the first few times, but decided to walk on their own for the remainder of the six weeks. Depending on the weather, they either walked outside or inside on a track.

T'ai Chi Chih movements and the ending pose were progressively taught for the first three weeks. At the beginning and end of each class the instructor asked for feedback from the subjects about the pace of the learning and also if they wanted to review any movements. Two videotapes of the certified instructor were available to the subjects to check out if they were absent from a class, or wanted to review over the weekend. The researchers encouraged the subjects to practice the movements learned in class on their own time.

### **Data Analysis**

The data from the post and pre test assessments for both the T'ai Chi Chih group and the walking group was entered into the SPSS<sup>™</sup> software system. With this program, the mean, standard deviation, mean difference and standard deviation difference were calculated. These parameters were used to detect significant changes in blood pressure or balance between the initial and final assessments of blood pressure, functional reach, single leg stance, and rhythmic weight shift.

### **Reporting Results**

Upon completion of this study, a summary of the results will be completed and sent to the T'ai Chi Chih instructor and the subjects. A copy of this independent study will be given to the preceptor involved with this research project and to the Harley E

French Library of Health Sciences to be available to interested parties. This study was completed to fulfill the requirements for the University of North Dakota School of Medicine and Health Sciences Physical Therapy Program.



## **CHAPTER IV**

### **RESULTS**

#### **Statistical Analysis**

The Statistical Power for the Social Sciences (SPSS 8.0<sup>TM</sup>) program was used for statistical analysis. All data was analyzed using a two-tail design with a level of significance of  $p < .05$ .

Data determined to be normally distributed was analyzed using a paired samples t-test. The paired samples t-test compared difference between the pre-intervention (test one) and post-intervention (test two) scores for: functional reach, right single leg stance eyes closed (RSLS-EC), systolic and diastolic blood pressure, rhythmic weight shift left and right (RWS-L/R) for velocity and directional control, and rhythmic weight shift forward and backward (RWS-F/B) for directional control.

Data determined to be skewed or kurtosed was analyzed using the Wilcoxin signed ranks test. The Wilcoxin test compared the difference between the pre-intervention and post-intervention scores for right single leg stance eyes open, (RSLS-EO) left single leg stance eyes opened (LSLS-EO) and closed (LSLS-EC). All balance scores were converted to ordinal data prior to analysis by the Wilcoxin test. All single leg stance scores of 120 seconds or more were recorded as 120 seconds for statistical purposes.

## Results

Means for test one and test two scores, and mean differences (test one score minus test two score) were computed for the T'ai Chi Chih group (table 1) and the walking group (table 2).

A significant decrease in systolic blood pressure ( $p = .000$ ) and diastolic blood pressure ( $p = .000$ ) was found, in the T'ai Chi Chih group, when comparing test one scores to test two scores (table 3). The mean difference was found to be 13.27 mm Hg for systolic blood pressure and 15.09 mm Hg for diastolic blood pressure. An increase was also found in the mean velocity of rhythmic weight shift left to right ( $p = .078$ ), but was not large enough to satisfy the requirements for statistical significance.

In the walking group, a significant increase in left single-leg stance time with eyes closed was found when comparing test one scores to test two scores (table 5). The mean difference was found to be -9.46 indicating the subjects were able to stand an average of 9.46 seconds longer after participating in the five week walking program.

As stated in the methods, participants were required to attend T'ai Chi Chih classes three times a week or practice at home if absent. Attendance was taken before each class with the average number of T'ai Chi Chih sessions not performed being two per participant with a range of 0-4.

Table 2. T'ai Chi Chih Group: Measurements and Paired Samples t-test

TEST	Test 1 M $\pm$ SD	Test 2 M $\pm$ SD	(Test 2-Test 1) M $\pm$ SD	df	t-statistic	p
Functional Reach	17.00 $\pm$ 2.47	16.16 $\pm$ 3.00	.884 $\pm$ 2.46	10	1.131	.284
Systolic B.P.	127.00 $\pm$ 7.82	113.73 $\pm$ 9.09	13.27 $\pm$ 8.53	10	5.159	.000*
Diastolic B.P.	68.82 $\pm$ 6.54	53.73 $\pm$ 3.95	15.09 $\pm$ 4.95	10	10.114	.000*
R Single Leg Stance eyes closed	32.78 $\pm$ 29.90	36.97 $\pm$ 35.59	-4.20 $\pm$ 14.87	10	-.936	.371
Rhythmic Weight Shift L/R (velocity)	7.13 $\pm$ 1.31	6.53 $\pm$ .89	.60 $\pm$ 1.02	10	1.964	.078
Rhythmic Weight Shift F/B (velocity)	4.15 $\pm$ .73	4.27 $\pm$ .77	-.13 $\pm$ .56	10	-.755	.467
Rhythmic Weight Shift L/R (directional control)	89.82 $\pm$ 2.48	90.09 $\pm$ 4.50	-.27 $\pm$ 5.10	10	-.177	.863
Rhythmic Weight Shift F/B (directional control)	80.82 $\pm$ 11.68	85.82 $\pm$ 6.19	-5.00 $\pm$ 13.25	10	-1.251	.239

\* 000 < p = .05 indicating a significant difference

Table 3. T'ai Chi Chih Group: Measurements and Wilcoxin Signed Ranks Test

TEST	Test M $\pm$ SD	Test 2 M $\pm$ SD	(Test 2-Test 1) M $\pm$ SD	n	z-score	p
R Single Leg Stance eyes open	106.61 $\pm$ 31.29	117.23 $\pm$ 7.43	-10.62 $\pm$ 25.39	10	-1.095	.273
L Single Leg Stance eyes open	114.23 $\pm$ 19.15	114.27 $\pm$ 19.00	- 4.55 $\pm$ .15	10	-1.000	.317
L Single Leg Stance eyes closed	31.56 $\pm$ 23.27	34.47 $\pm$ 33.60	- 2.91 $\pm$ 19.25	10	- .356	.722

Table 4. Walking Group: Measurements and Paired Samples t-test

TEST	Test 1 M $\pm$ SD	Test 2 M $\pm$ SD	(Test 2-Test 1) M $\pm$ SD	df	t-statistic	p
Functional Reach	15.63 $\pm$ 3.29	16.47 $\pm$ 3.49	- .84 $\pm$ 1.06	4	-1.781	.150
Systolic B.P.	122.80 $\pm$ 12.56	122.80 $\pm$ 12.56	10.60 $\pm$ 13.89	4	1.707	.163
Diastolic B.P.	68.40 $\pm$ 11.26	60.20 $\pm$ 7.09	8.20 $\pm$ 10.55	4	1.734	.157
R Single Leg Stance eyes open	95.76 $\pm$ 24.76	107.40 $\pm$ 28.18	-11.64 $\pm$ 18.79	4	-1.385	.238
Right Single Leg Stance eyes closed	18.91 $\pm$ 10.95	27.02 $\pm$ 6.26	- 8.11 $\pm$ 12.34	4	-1.470	.216
Lef Single Leg Stance eyes open	96.93 $\pm$ 33.15	108.40 $\pm$ 25.94	- 11.47 $\pm$ 34.34	4	-7.470	.497
Left Single Leg Stance eyes closed	15.91 $\pm$ 7.08	25.37 $\pm$ 7.52	- 9.46 $\pm$ 3.68	4	-5.739	.005*
Rhythmic Weight Shift L/R (velocity)	6.40 $\pm$ .39	6.20 $\pm$ .51	.20 $\pm$ .30	4	1.491	.210
Rhythmic Weight Shift F/B (velocity)	4.12 $\pm$ .54	3.88 $\pm$ .86	.24 $\pm$ .38	4	1.419	.229
Rhythmic Weight Shift L/R (directional control)	89.20 $\pm$ 2.78	87.80 $\pm$ 3.27	1.40 $\pm$ 3.78	4	.828	.454
Rhythmic Weight Shift F/B (directional control)	82.60 $\pm$ 5.13	83.20 $\pm$ 10.59	- .60 $\pm$ 12.90	4	-.104	.922

\* .005 < p = .05 indicating a significant difference

## CHAPTER V

### DISCUSSION

The purpose of this study was to determine if T'ai Chi Chih has an effect on balance and/or blood pressure in a population, ages 20-39. Significant decreases in both systolic and diastolic blood pressure were found in the T'ai Chi Chih group. The mean for systolic blood pressure was reduced from 127.00 mmHg, at test one, to 113.73 mmHg, at test 2, for a mean difference of 13.27 mmHg (figure2). While the mean for diastolic blood pressure was reduced from 68.82 mmHg to 53.73 mmHg for a mean difference of 15.09 mmHg (figure 2). None of the results for blood pressure were significant in the walking group.

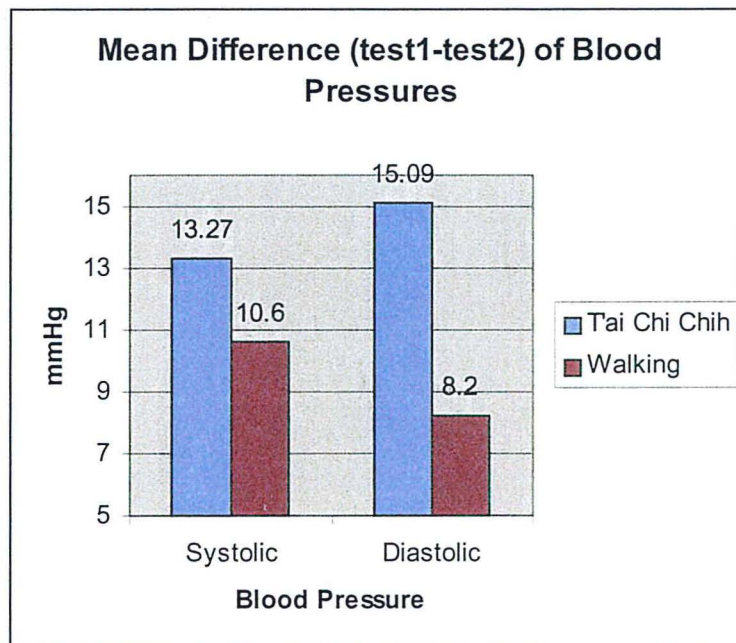


Figure 2. T'ai Chi Chih vs. walking, mean difference in blood pressures

This information is consistent with Young et al<sup>25</sup> who found significant decreases in blood pressure, in subjects over 60 years of age, after a 12-week T'ai Chi program. In comparison, however, the results of this study are particularly interesting in that blood pressure was reduced in a younger population, with presumably no health problems, who practiced three times a week for only five weeks. A compounding variable, which makes this finding even more interesting, is that significant decreases in blood pressure were found even though the final testing (test 2) was performed during finals week, a normally very high stress time for students which would presumably cause increased blood pressure secondary to anxiety and stress.

This decrease in blood pressure, especially during finals week, helps support Jin's<sup>31</sup> study on changes in heart rate, noradrenaline, cortisol and mood during T'ai Chi practice. Jin found T'ai Chi practice produced less tension, depression, fatigue and state anxiety. Future studies could use similar objective measurements for stress and anxiety to test the effects on the younger population.

It can also be deduced, from this decrease in blood pressure that the subjects experienced significant cardiorespiratory effects as a result of T'ai Chi Chih practice. This information would support studies, which found T'ai Chi to be an aerobic exercise of moderate intensity.<sup>3</sup> Wolf<sup>8</sup> also conducted a study that found T'ai Chi had similar cardiorespiratory benefits to those of brisk walking.

While a significant decrease in blood pressure was found, balance statistics showed no significant changes. Actually, the opposite was expected since Judge et al<sup>18</sup> found significant improvements in single leg stance test and postural sway in older

women using T'ai Chi and Snychaller<sup>32</sup> found T'ai Chi intervention improved mean eyes open single leg stance scores by 50%.

Although a general improvement in single leg stance (SLS) scores, eyes open and eyes closed, was found in the T'ai Chi group, the results were not significant. This lack of significant statistical findings in SLS could be attributed to the age of the population or the duration of T'ai Chi Chih intervention. At initial testing most of the subjects were able to stand with eyes open for the full 120 seconds on both the right and left legs, so there was no room for improvement. A more sensitive test for SLS, possibly timing the test until loss of balance occurs, is recommended for future studies performed on this population. However, this is very time consuming, so another more challenging/sensitive test such as those of the Neurocom Balance Master® may be more beneficial.

Another limitation of the SLS test could have been the duration of the T'ai Chi Chih intervention. A five-week program might not have been sufficient to produce changes in the balance systems of this population. A study of longer duration and increased frequency of practice may produce significant results in future studies.

Since many T'ai Chi Chih movements involve shifting weight from left to right, or front to back, we hypothesized rhythmic weight shifting(RWS) velocity and directional control would improve. Actually, there were no significant findings in this population. RWS, left to right, velocity was improved, but not significantly. This could again indicate the need for longer duration of intervention or increased frequency of practice to produce results in this population.

Significant and interesting results were also found in reference to the walking group. Subjects were able to perform the LSLS-EC test for a mean of 15.91 seconds, at



test one, and by test two they were able to perform the test for a mean of 25.37 seconds, a mean difference of 9.46 seconds longer.

Although all other areas tested were improved in the walking group, none of the results were significant. This could have been the result of a very small sample size (four, at final testing) or the large range of participation time. Subjects were asked to keep a walking log, but lack of communication between the researchers and participants hindered access to that information. The inclusion of the walking group was a good intention, but more structured walking sessions with attendance and a required meeting time and location would be beneficial for future studies.

Other limitations in this study were the small sample sizes in both the T'ai Chi Chih and walking groups. At final testing the T'ai Chi Chih group consisted of ten subjects and the walking group, four. These groups are not large enough to generalize their results to the entire population, groups of 30 or more are required for this and suggested for future studies.

These differences in sample size between groups may count for something, however. Participants in the T'ai Chi Chih group showed greater interest in the activity before during and after the intervention. A large number of people signed up for the study with an expressed interest in T'ai Chi Chih, not walking, and in fact mention of the walking group deterred some people from signing up for the study. One participant requested information on where to obtain the music used in class so he could practice T'ai Chi Chih on his own, at the conclusion of the study. Others requested a list of the movements to make practice at home easier.

Participants in the walking group seemed to lack interest, in fact three subjects dropped out of the study because of disinterest. T'ai Chi Chih then may be useful for Physical Therapists to use with patients finding difficulty complying with traditional exercise programs including those of moderate aerobic intensity.

### **Conclusion**

While this study had some limitations, the results, which were significant, are still interesting. The literature shows T'ai Chi can positively augment a Physical Therapist's treatment to improve patients' balance, posture, coordination, endurance, strength, flexibility, and provide relaxation.<sup>32-37</sup> This study supplements that information by showing that regular T'ai Chi Chih practice can significantly reduce both systolic and diastolic blood pressure in young adults, ages 20-39. More research is needed, especially on this population, but with that T'ai Chi Chih could prove to be a very effective supplement to all types of physical therapy rehabilitation and wellness programs.

## **APPENDIX A**

☒ EXPEDITED REVIEW REQUESTED UNDER ITEM \_\_\_\_\_ (NUMBER[S]) OF HHS REGULATIONS  
\_\_\_\_ EXEMPT REVIEW REQUESTED UNDER ITEM \_\_\_\_\_ (NUMBER[S]) OF HHS REGULATIONS

UNIVERSITY OF NORTH DAKOTA HUMAN SUBJECTS REVIEW FORM  
FOR NEW PROJECTS OR PROCEDURAL REVISIONS TO APPROVED  
PROJECTS INVOLVING HUMAN SUBJECTS

Please include ALL information and check ALL blanks that apply.

PRINCIPAL INVESTIGATOR: Beverly Johnson, Anita Osland, Sarah Williams, Jen Baumgartner TELEPHONE: 777-3821 DATE: 3/6/00

ADDRESS TO WHICH NOTICE OF APPROVAL SHOULD BE SENT: UND-PT P.O. Box 9037 Grand Forks, ND

SCHOOL/COLLEGE: Medicine DEPARTMENT: Physical Therapy PROPOSED PROJECT DATES: 4/3/00-5/5/00

PROJECT TITLE: T'ai Chi Chih and its effect on balance and blood pressure

FUNDING AGENCIES (IF APPLICABLE): \_\_\_\_\_

TYPE OF PROJECT (Check ALL that apply):

NEW PROJECT ☒ CONTINUATION \_\_\_\_\_ RENEWAL \_\_\_\_\_ DISSERTATION OR THESIS RESEARCH ☒ STUDENT RESEARCH PROJECT \_\_\_\_\_  
CHANGE IN PROCEDURE FOR A PREVIOUSLY APPROVED PROJECT \_\_\_\_\_

DISSERTATION/THESIS ADVISER, OR STUDENT ADVISER: Beverly Johnson PT, MS

PROPOSED PROJECT: \_\_\_\_\_ INVOLVES NEW DRUGS (IND) \_\_\_\_\_ INVOLVES NON-APPROVED USE OF DRUG \_\_\_\_\_ INVOLVES A COOPERATING INSTITUTION \_\_\_\_\_

IF ANY OF YOUR SUBJECTS FALL IN ANY OF THE FOLLOWING CLASSIFICATION, PLEASE INDICATE THE CLASSIFICATION(S):

☐ MINORS (<18 YEARS) ☐ PREGNANT WOMEN ☐ MENTALLY DISABLED ☐ FETUSES ☐ PERSONS WITH  
☐ PRISONERS ☐ ABORTUSES ☒ UND STUDENTS (>18 YEARS)

IF YOUR PROJECT INVOLVES ANY HUMAN TISSUE, BODY FLUIDS, PATHOLOGICAL SPECIMENS, DONATED ORGANS, FETAL MATERIAL, OR PLACENTAL MATERIALS, CHECK HERE \_\_\_\_\_

IF YOUR PROJECT HAS BEEN WILL BE SUBMITTED TO ANOTHER INSTITUTIONAL REVIEW BOARD(S), PLEASE LIST NAME OF BOARD(S): \_\_\_\_\_

Status: \_\_\_\_\_ Submitted; Date \_\_\_\_\_ Approved; Date \_\_\_\_\_ Pending

1. ABSTRACT: (LIMIT TO 200 WORDS OR LESS AND INCLUDE JUSTIFICATION OR NECESSITY FOR USING HUMAN SUBJECTS.) The purpose of this study is to determine if a 5 week structured t'ai chi chih program promotes a change in balance or blood pressure in a population of 20-39 year old subjects. T'ai chi chih is a form of exercise and meditation developed in the far east that combines deep diaphragmatic breathing with good posture while performing slow, gentle movements. T'ai chi chih has been effective in decreasing chronic pain, blood pressure, and heart rate, improving balance and strength and encouraging overall relaxation. Although there are many benefits to using t'ai chi chih, most of the literature relates to the elderly population. Most of this limited literature lacks sophistication in the measurement of balance and fails to address the affects t'ai chi chih has on dynamic and functional balance. Therefore, our focus in performing this study will be to add to the body of knowledge of t'ai chi chih and to investigate the impact it has on blood pressure and balance in the population, ages 20-39. The investigators will recruit subjects by visiting classrooms throughout the UND campus. Considering previous studies, we expect that both the t'ai chi chih and walking groups will have decreased blood pressure and improved balance.

**PLEASE NOTE:** Only information pertinent to your request to utilize human subjects in your project or activity should be included on this form. Where appropriate attach sections from your proposal (if seeking outside funding).

**2. PROTOCOL:** (Describe procedures to which humans will be subjected. Use additional pages if necessary. Attach any surveys, tests, questionnaires, interview questions, examples of interview questions (if qualitative research), etc., the subjects will be asked to complete.)

**Recruitment:** The investigators will recruit subjects by visiting classrooms throughout the UND campus. A total of 20-30 subjects are required for this study.

**Selection:** Subjects will meet the requirements if they are 20-39 years of age, attend, work, or teach at UND and are currently engaging in no more than 30-40 minutes of aerobic exercise three times a week. Subjects will be informed of their exclusion from the study if they have a history of cardiac health problems or hypertension.

**Procedures:** This study requires 20-30 subjects, ages 20-39, to be used in a five-week study of the effects of t'ai chi chih on balance, and blood pressure. Subjects will be randomly assigned to either a t'ai chi chih or walking group. Initially, all subjects will have their blood pressure tested, and their balance tested on the NeuroCom® Balance Master to determine baseline data. Then, the t'ai chi chih group will participate in 45-60 minute exercise sessions three times per week for five weeks. One session a week will be led by a certified t'ai chi chih instructor and the two remaining sessions will be led by the investigators with the assistance of a video. One of the investigators will lead the walking group, which will walk three times per week, approximately 45 minutes, for five weeks. At the end of the five weeks, both groups will repeat the balance master test and have their blood pressure tested. The t'ai chi chih session, walking, and testing will take place on the campus of the University of North Dakota. Data collected from the study will then be statistically analyzed to compare the two groups of subjects and relate those values to the norms.

**Informed consent:** Each subject will receive a consent form, which outlines the study and any potential risks. Once subjects have reviewed the consent form, investigators will be available to answer any questions. Written, informed consent will be obtained from all subjects. (see attached form)

**Risk:** Personal injury is always a risk with exercise, including t'ai chi chih. Risk of injury while performing t'ai chi chih is thought to be minimal in the population of this study. Subjects will be excluded if they have a history of cardiac health problems or hypertension. Subjects will be informed that termination of activity is possible at any time. Termination will not prejudice their future relationship with the Physical Therapy Department, School of Medicine and Health Sciences, or the University of North Dakota. The certified t'ai chi chih instructor or the investigators will be present during all exercise sessions. If personal injury occurs during an exercise class, subjects will be encouraged to seek medical assistance or if necessary a medical emergency team will be contacted. The subject or their third party payer will be responsible for paying for these services.

**Compensation:** Subjects will receive no monetary compensation for participating in this study. The customary charge for the t'ai chi chih course will be waived.

**3. BENEFITS:** (Describe the benefits to the individual or society.)

Stress and high blood pressure are often problems that university students and society in general, face and can become serious if not controlled properly. Problems with balance in this age group may not be functionally imitating, but may need improvements. This study will compare the affects that t'ai chi chih and walking have on balance, blood pressure. Several studies have been conducted to show the effects of t'ai chi chih on balance, blood pressure. However, many of these studies have focused on elderly subjects, where as this study will concentrate on college subjects.

Our subjects will obtain several benefits from participating in this study. All subjects may personally benefit from participation in this study by contributing to the furthering of knowledge in the health sciences. Those participating in the t'ai chi chih and walking groups may experience the benefits of improved balance and decreased blood pressure. Also, t'ai chi chih classes taken elsewhere require a certain fee, the subjects in this study will participate in the class for free.

4. **RISKS:** (Describe the risks to the subject and precautions that will be taken to minimize them. The concept of risk goes beyond physical risk and includes risks to the subject's dignity and self-respect, as well as psychological, emotional or behavioral risk. If data are collected which could prove harmful or embarrassing to the subject if associated with him or her, then describe the methods to be used to protect the confidentiality of data obtained, debriefing procedures, storage of data, how long data will be stored (must be a minimum of three years), final disposition of data, etc.)

Personal injury is always a risk with exercise, including t'ai chi chih. Risk of injury while performing t'ai chi chih is thought to be minimal in the population of this study. Subjects will be excluded if they have a history of cardiac health problems or hypertension. Subjects will be informed that termination of activity is possible at any time. Termination will not prejudice their future relationship with the Physical Therapy Department or the University of North Dakota. The certified t'ai chi chih instructor or the investigators will be present during all exercise sessions. If personal injury occurs during an exercise class, subjects will be encouraged to seek medical assistance, which the subject or their third party payer will be responsible for paying.

The reports and results of this study will be coded and will not include the subject's names or personal information. Any information that is obtained in connection with this study and that can be identified with the subjects will remain confidential. All data from this study will be retained in a locked office in the UND physical therapy department for three years following completion of this study. Only those associated with conducting the study and the department director will have access to this information. All data will be shredded at the end of the three-year period.

5. **CONSENT FORM:** Attach a copy of the **CONSENT FORM** to be signed by the subject (if applicable) and/or any statement to be read to the subject should be attached to this form. If no **CONSENT FORM** is to be used, document the procedures to be used to assure that infringement upon the subject's rights will not occur.

Describe where signed consent forms will be kept and for how long (must be a minimum of 3 years), including plans for final disposition or destruction.

All consent forms from this study will be retained in a locked office in the UND physical therapy department for three years following completion of this study. Only those associated with conducting the study and the department director will have access to this information. A copy of the consent form to be used is attached.

6. For **FULL IRB REVIEW** forward a signed original and fifteen (15) copies of this completed form, including fifteen (15) copies of the proposed consent form, questionnaires, examples of interview questions, etc. and any supporting documentation to the address below. An original and 19 copies are required for clinical medical projects. In cases where the proposed work is part of a proposal to a potential funding source, one copy of the completed proposal to the funding agency (agreement/contract if there is no proposal) must be attached to the completed Human Subjects Review Form if the proposal is non-clinical; 7 copies if the proposal is clinical medical. If the proposed work is being conducted for a pharmaceutical company, 7 copies of the company's protocol must be provided.

Office of Research & Program Development  
University of North Dakota  
Grand Forks, North Dakota 58202-7134

On campus, mail to: Office of Research & Program Development, Box 7134, or drop it off at Room 105 Twamley Hall.

For **EXEMPT** or **EXPEDITED REVIEW** forward a signed original, including a copy of the consent form, questionnaires, examples of interview questions, etc. and any supporting documentation to one of the addresses above. In cases where the proposed work is part of a proposal to a potential funding source, one copy of the completed proposal to the funding agency (agreement/contract if there is no proposal) must be attached to the completed Human Subjects Review Form.

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The policies and procedures on Use of Human Subjects of the University of North Dakota apply to all activities involving use of Human Subjects performed by personnel conducting such activities under the auspices of the University. No activities are to be initiated without prior review and approval as prescribed by the University's policies and procedures governing the use of human subjects.

**SIGNATURES:**

\_\_\_\_\_  
Principal Investigator

\_\_\_\_\_  
Date

\_\_\_\_\_  
Project Director or Student Adviser

\_\_\_\_\_  
Date

\_\_\_\_\_  
Training or Center Grant Director

\_\_\_\_\_  
Date

(Revised 2/2000)

## **APPENDIX B**



## Information and Consent Form

**Title:** *T'ai Chi Chih and its effects on balance and blood pressure.*

Sarah Williams, Jennifer Baumgartner and Anita Osland, physical therapy students at the University of North Dakota, invite you to participate in their study. The purpose of this study is to determine the effectiveness of t'ai chi chih in reducing blood pressure and stress, and improving balance. Only UND students, staff, or faculty 20-39 years of age who engage in no more than 30-40 minutes of aerobic exercise, per session, three times a week will be eligible to participate in this study.

Should you choose to participate, you will have your blood pressure tested, and your balance tested on the NeuroCom® Balance Master at the beginning and the end of the study. The Balance Master is a clinically accepted machine commonly used by physical therapists for assessment and balance training.

Subjects will be randomly assigned to either a t'ai chi chih or walking group. The t'ai chi chih group will participate in 45-60 minute exercise session three times a week for five weeks. A certified t'ai chi chih instructor will lead one session a week, and the two remaining sessions will be led by the investigators with the assistance of a video. The walking group will walk three times a week for approximately 45 minutes each session for six weeks, which will be led by one of the investigators. The t'ai chi chih, walking, and testing will take place on the campus of the University of North Dakota.

You may personally benefit from participation in this study by contributing to the furthering of knowledge in the health sciences. Also, those participating in the t'ai chi chih and walking groups may experience the benefits of improved balance and decreased stress and blood pressure. Finally, certified t'ai chi instruction will be free of charge. You will receive no monetary compensation for participating in this study.

Personal injury is always a risk with exercise, including t'ai chi chih, however, the researchers of this study feel the risk of injury while performing t'ai chi chih is minimal. The certified t'ai chi chih instructor or investigators will be present during all exercise sessions to safeguard you against possible risks. Subjects with a history of cardiac health problems, or hypertension will be excluded. If personal injury occurs during an exercise class, you will be encouraged to seek medical attention. You or your third party payer must provide payment for any such treatment.

You may chose to discontinue the experiment at any time up until data collection is completed. Should you decide to discontinue or not participate, this will not prejudice your future relationship with the Physical Therapy Department, School of Medicine and Health Sciences, or the University of North Dakota.



Your identity will remain anonymous in any reports of the results of this study. Any information that is obtained in connection with this study and that can be identified with you will remain confidential. All data from this study will be coded and retained in a locked office in the UND physical therapy department for three years following completion of this study. At the end of the three-year period, all data will be shredded.

The investigators involved are available to answer any questions you have concerning this study. In addition, you are encouraged to ask any questions concerning this study that you may have in the future. Questions may be asked by calling Anita Osland at (701) 786-2716, Jennifer Baumgartner at (701) 772-0107, Sarah Williams at (701) 746-4218, or faculty advisor Beverly Johnson at (701) 777-3871. A copy of this consent form is available to all participants in this study.

**ALL OF MY QUESTIONS HAVE BEEN ANSWERED AND I AM  
ENCOURAGED TO ASK ANY QUESTIONS THAT I MAY HAVE  
CONCERNING THIS STUDY IN THE FUTURE.  
MY SIGNATURE INDICATED THAT I HAVE READ THE  
ABOVE INFORMATION, AND I HAVE DECIDED TO  
PARTICIPATE IN THE RESEARCH PROJECT.**

---

Participant's signature

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Date

---

Witness

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Date

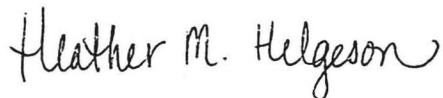
To Whom It May Concern:

I Heather M. Helgeson a Certified T'ai Chi Chih instructor have agreed to participate in this study with Jenny Baumgartner, Anita Osland, and Sarah Williams, students of the Physical Therapy Dept. at the University of North Dakota.

I was certified to teach T'ai Chi Chih to individuals in July of 1994, since that time I have instructed a variety of individuals both in the community as well as clinical settings at Altru Health Systems and The Center for Psychiatric Care.

I approve of the study utilizing T'ai Chi movements to further research the benefits that T'ai Chi Chih has on the decrease in blood pressure, improvement of balance, and any other benefits that may result from the study.

Sincerely,

A handwritten signature in cursive script that reads "Heather M. Helgeson". The signature is written in dark ink and is positioned below the word "Sincerely,".

Heather M. Helgeson

## **APPENDIX C**

## **RHYTHMIC WEIGHT SHIFT**

The inability to control the movement of center of gravity (COG) over the base of support would result in decreased balance abilities. The Rhythmic Weight Shift test is designed to examine the subject's ability to accelerate the COG to travel and to decelerate to change directions. Also, it examines the subject's ability to modify the timing of COG to match the cursor as seen on the computer terminal. Right/left and backward/forward movements of COG are tested.

There are three assessment levels in all of the tests included in the NCBM. The researchers chose highest level, Assessment Level Three, because of the population of the subjects. The pace set by the cursor for this level is one second per transition. The subject must complete at least four out the six transitions for the computer to generate a valid score.

The parameters measured during the Rhythmic Weight Shift test include on-axis-velocity and directional control. The researchers chose to use directional control, because the results of the pilot study showed the researcher to be reliable only for directional control, not on-axis-velocity. Directional control compares the movement intended towards the end line to the amount of extraneous movement away from the end line. The following formula demonstrates how directional control is calculated.

$$\frac{(\text{amount of intended movement}) - (\text{amount of extraneous movement})}{(\text{amount of intended movement})}$$

This formula is expressed as a formula, and the perfect directional control score is 100%.

The scores represent how smooth and straight the subject is able to move from one end to the other.

Looking at the directional control graph, the first bar shows the average COG control for right/left weight shifting, and the second bar shows the average COG control for the backward/forward weight shifting. The third bar represents the average COG control for both directions combined. If the subject's score were in the gray region of the graph, it would indicate an abnormal score.

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